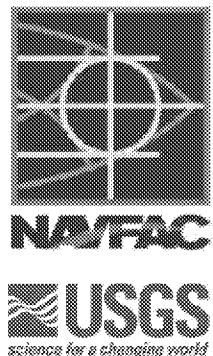


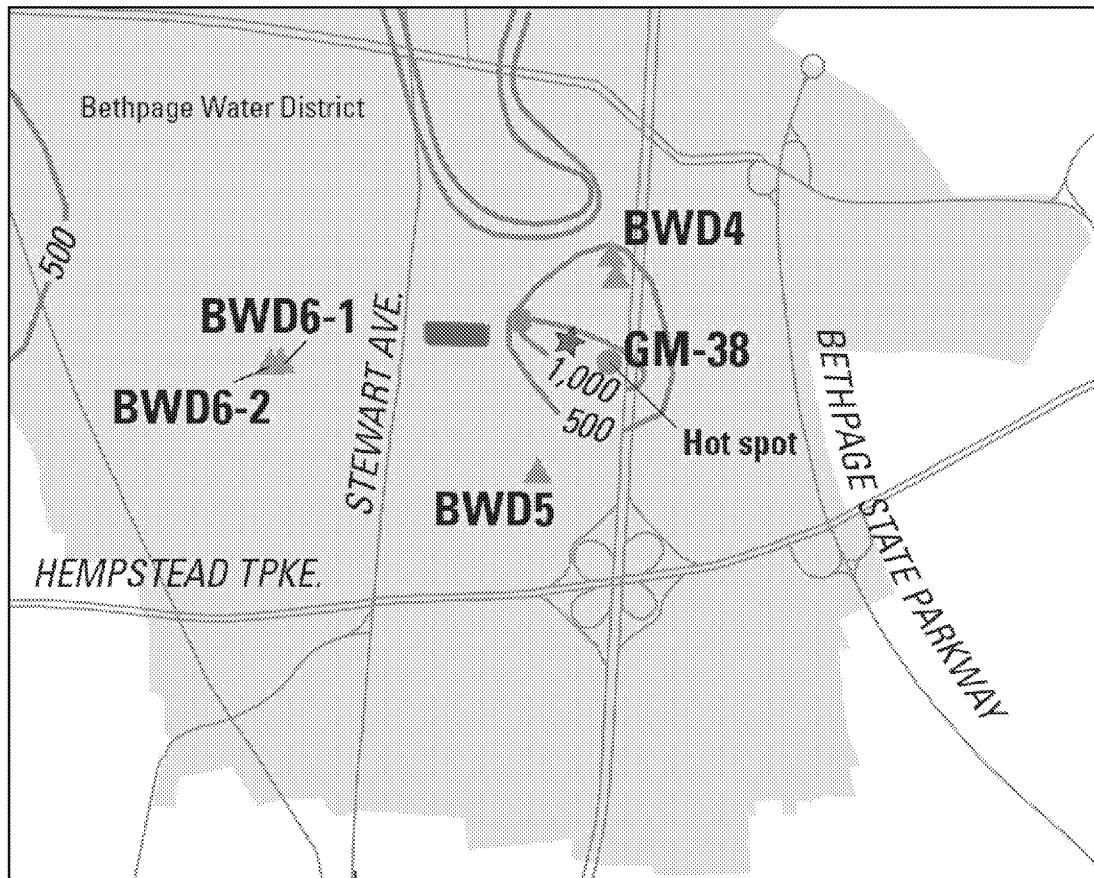
Simulation of zones of contribution to wells at site GM-38, Naval Weapons Industrial Reserve Plant, Bethpage, New York

*6th USGS/DEC Summit
November 13, 2014*

Paul Misut, USGS Coram

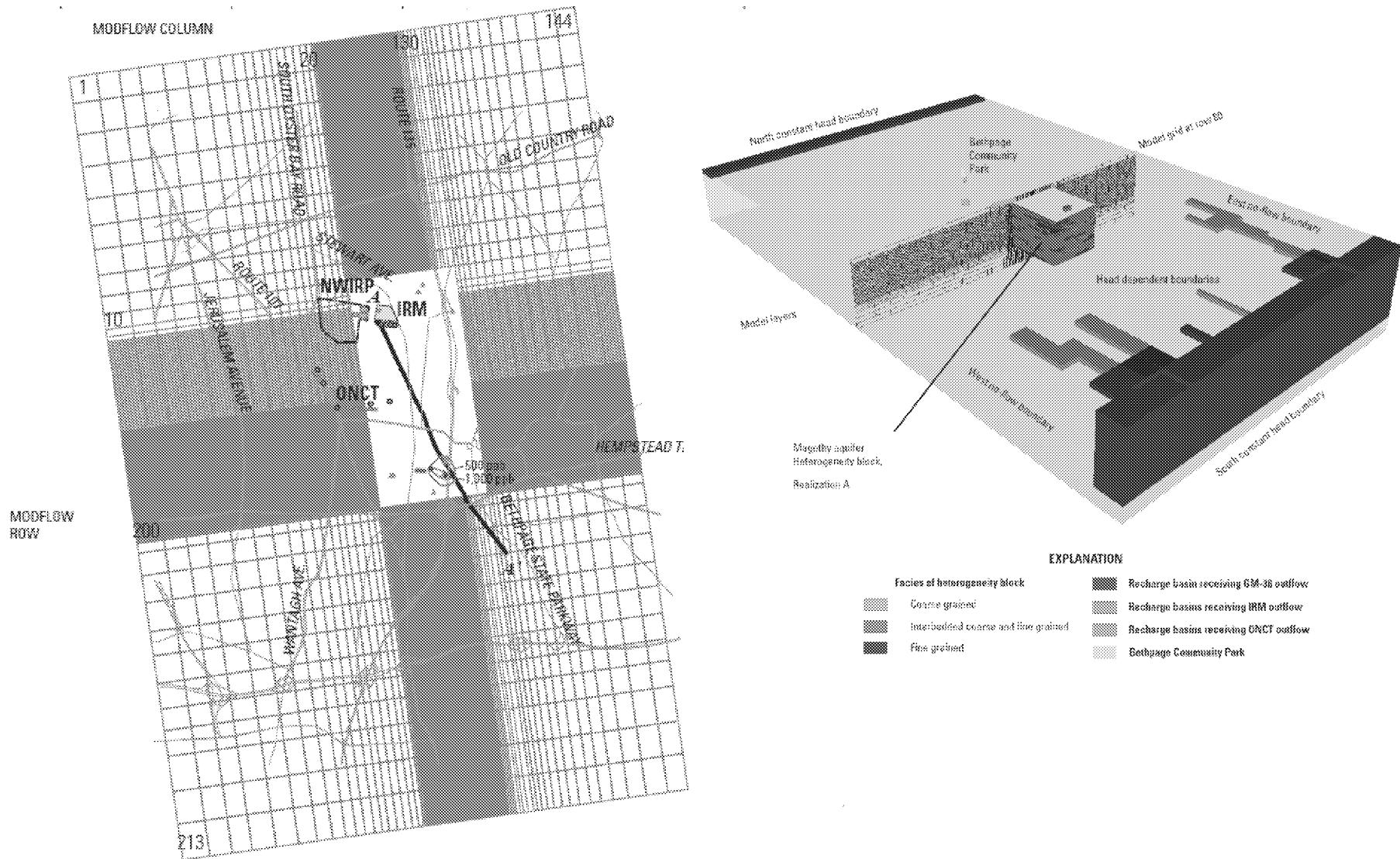


GENERAL
FLOW
DIRECTION

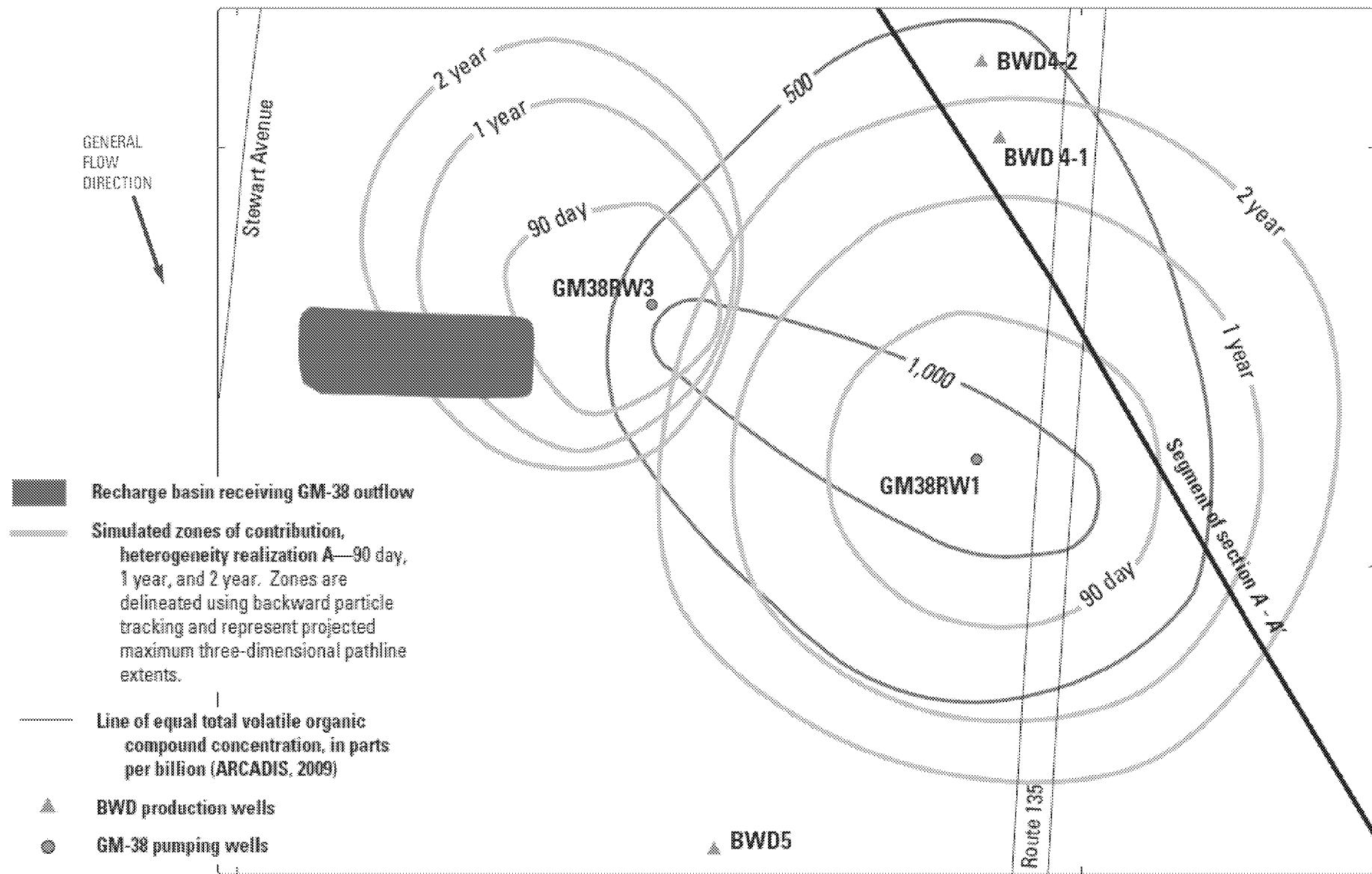


- Recharge basin receiving GM-38 outflow
- Line of equal total volatile organic compound concentration, in parts per billion
(from ARCADIS, 2009)
- ▲ Bethpage Water District (BWD) production wells
- Active GM-38 pumping wells (RW1 and RW3)
- ★ Inactive GM-38 pumping wells (RW2)

MODFLOW variable grid spacing : map and block diagram



Baseline simulated capture zones: map



Study questions:

How does aquifer heterogeneity affect particle tracking delineations?

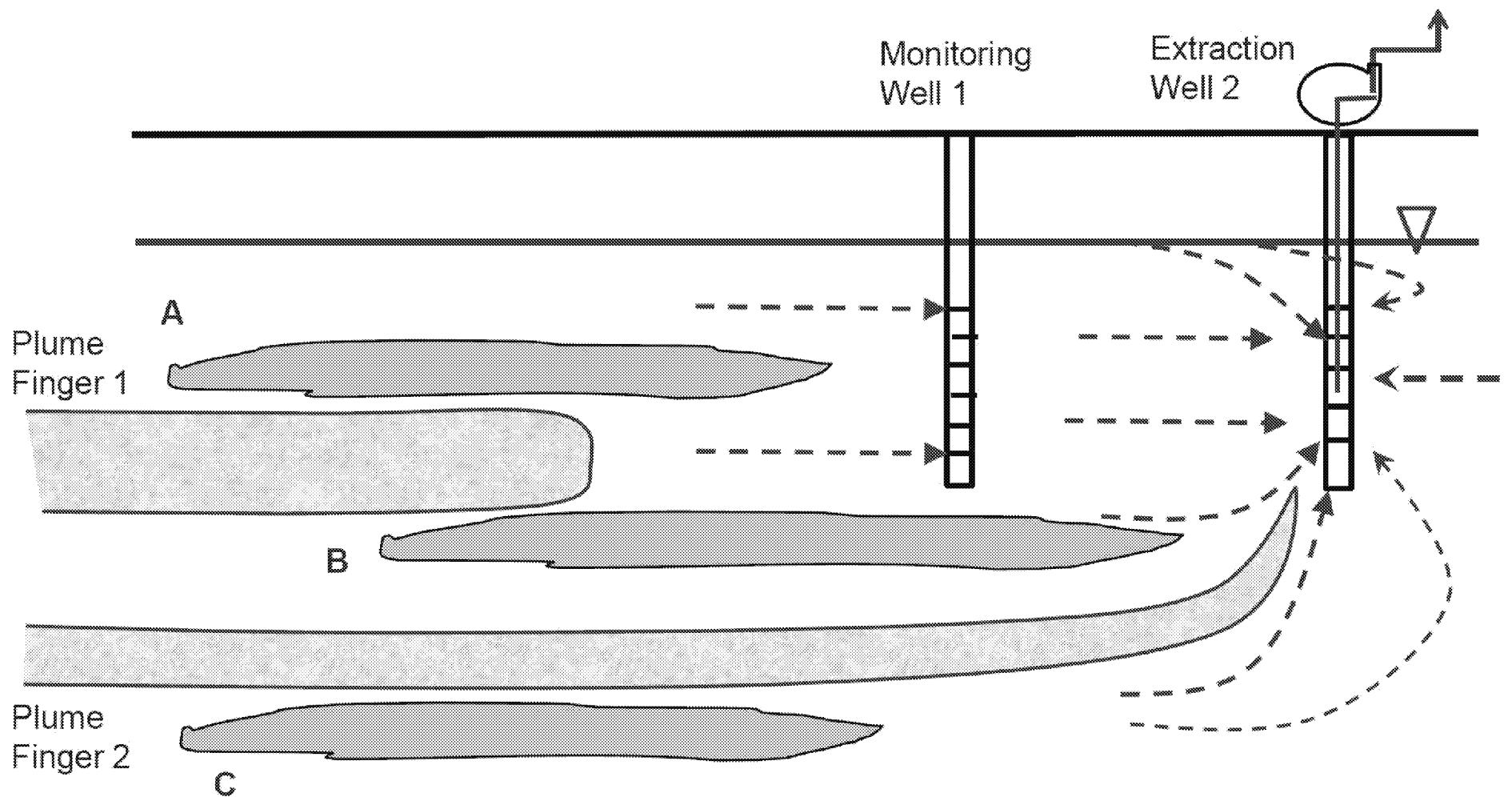
How do forward tracking and backward tracking methods compare?

How may the three GM38 pumping rates be optimized?

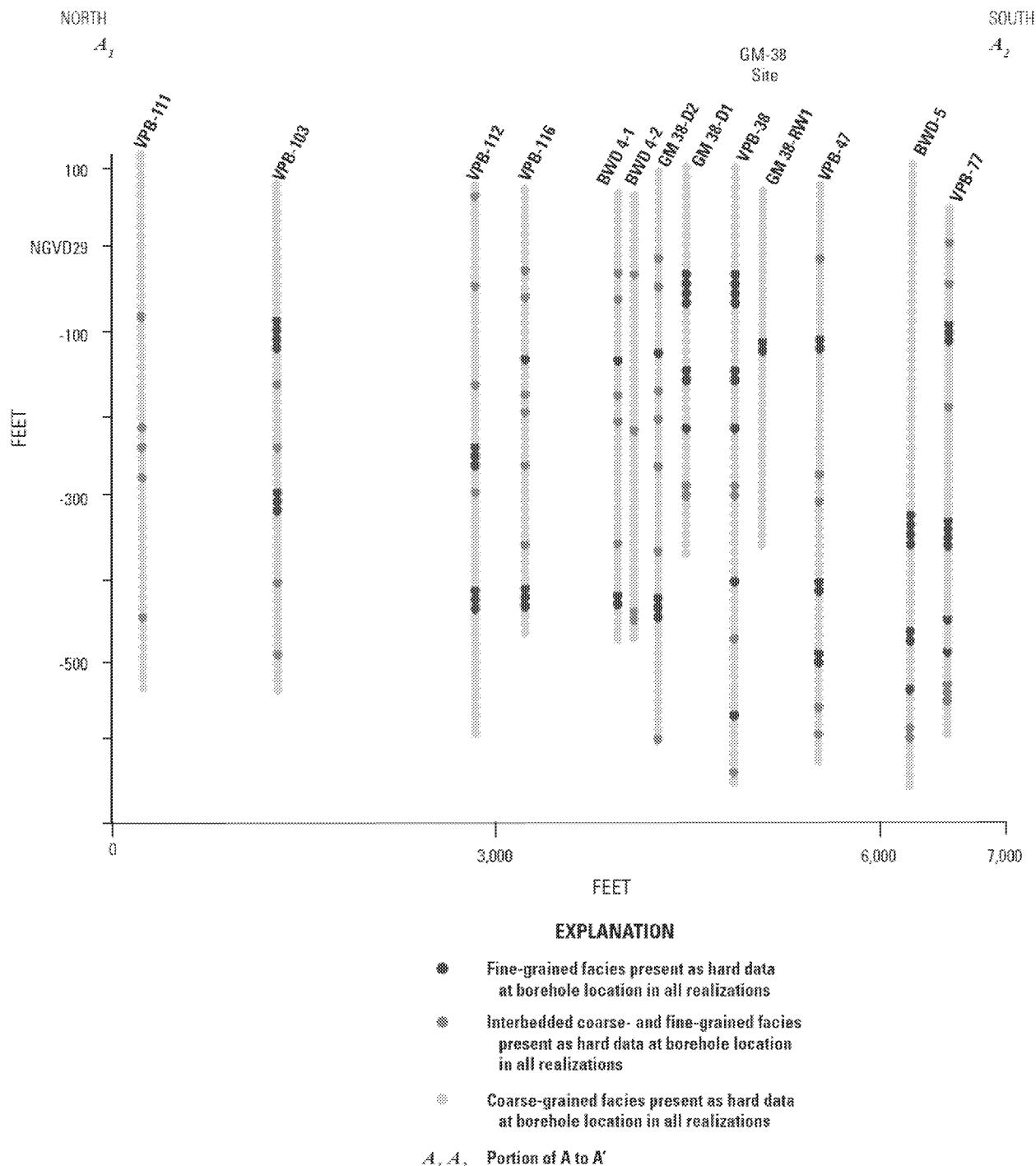
1. Heterogeneity
2. Forward tracking
3. Backward tracking
4. Conclusions

Navy conceptual model

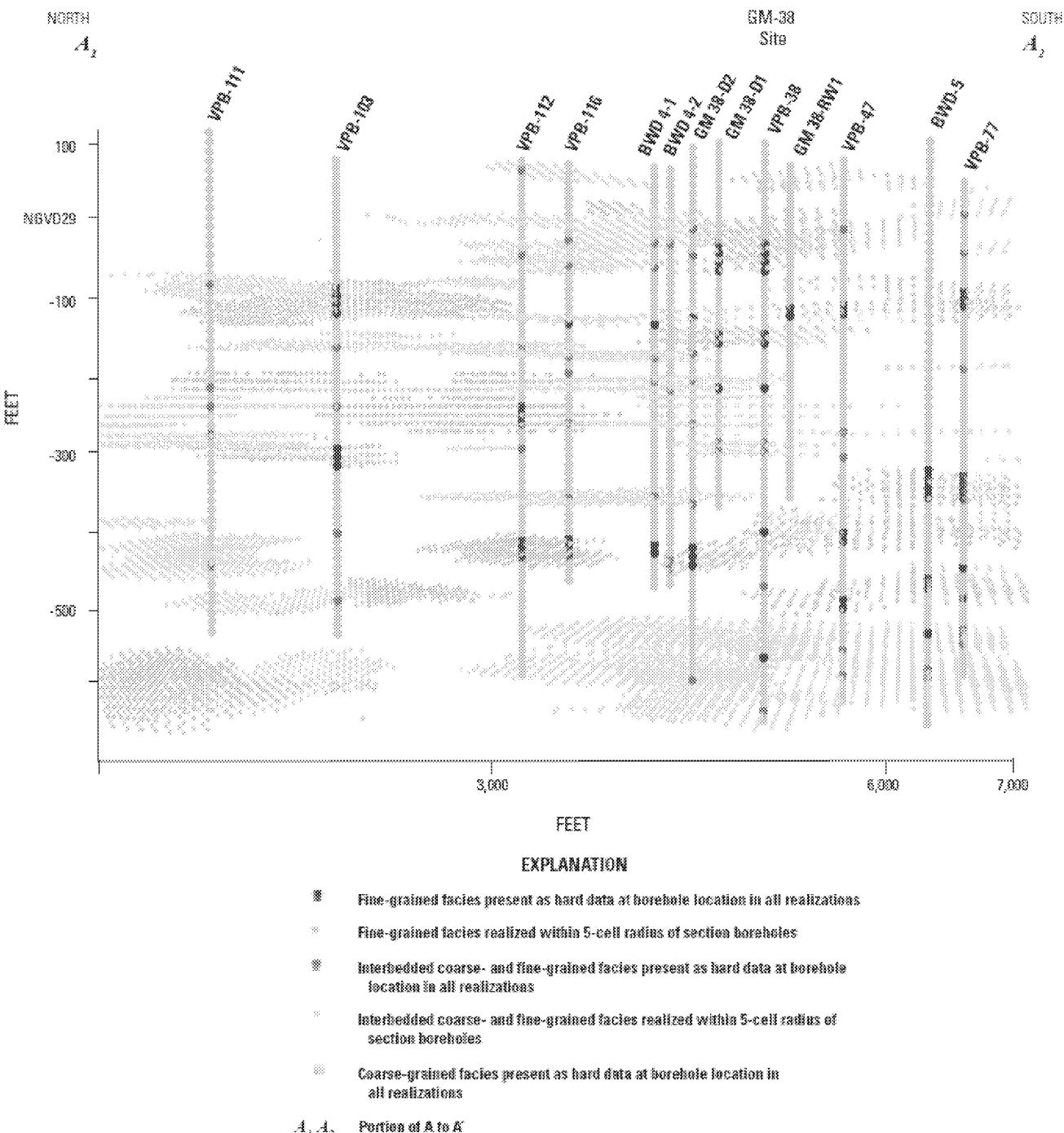
-subtle head differences observed



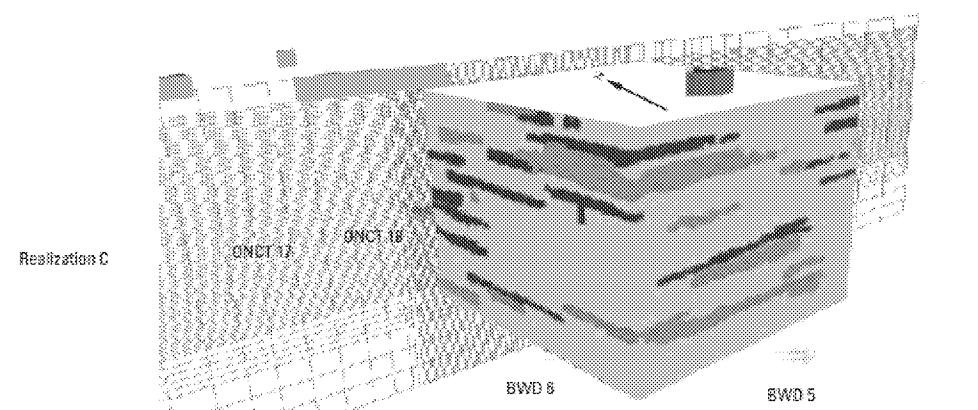
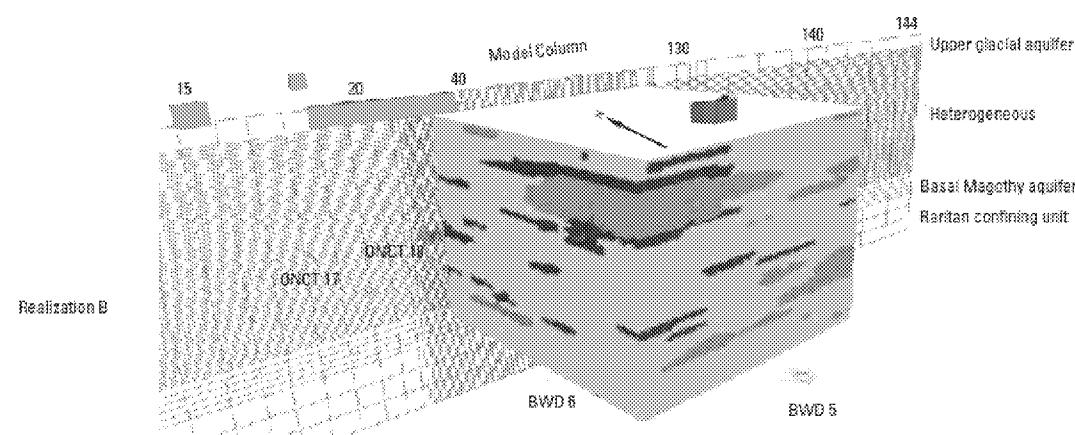
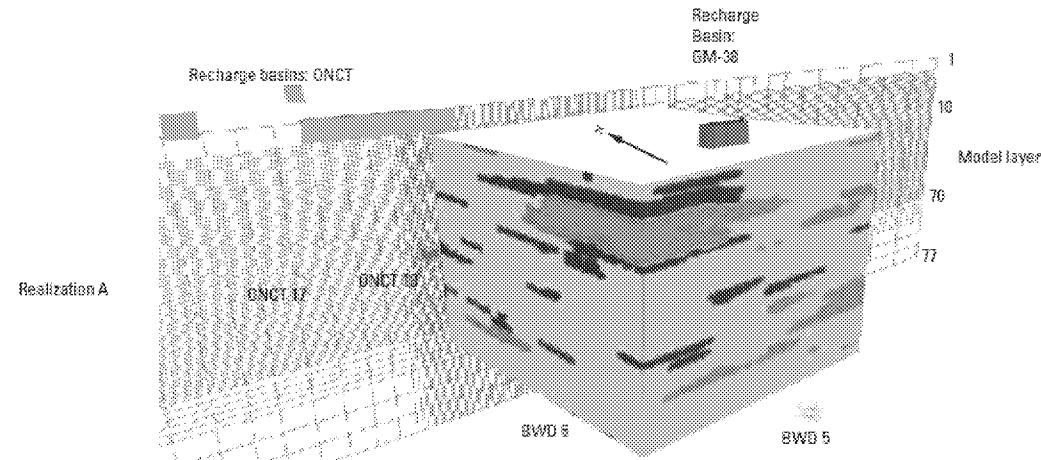
Hard data: section



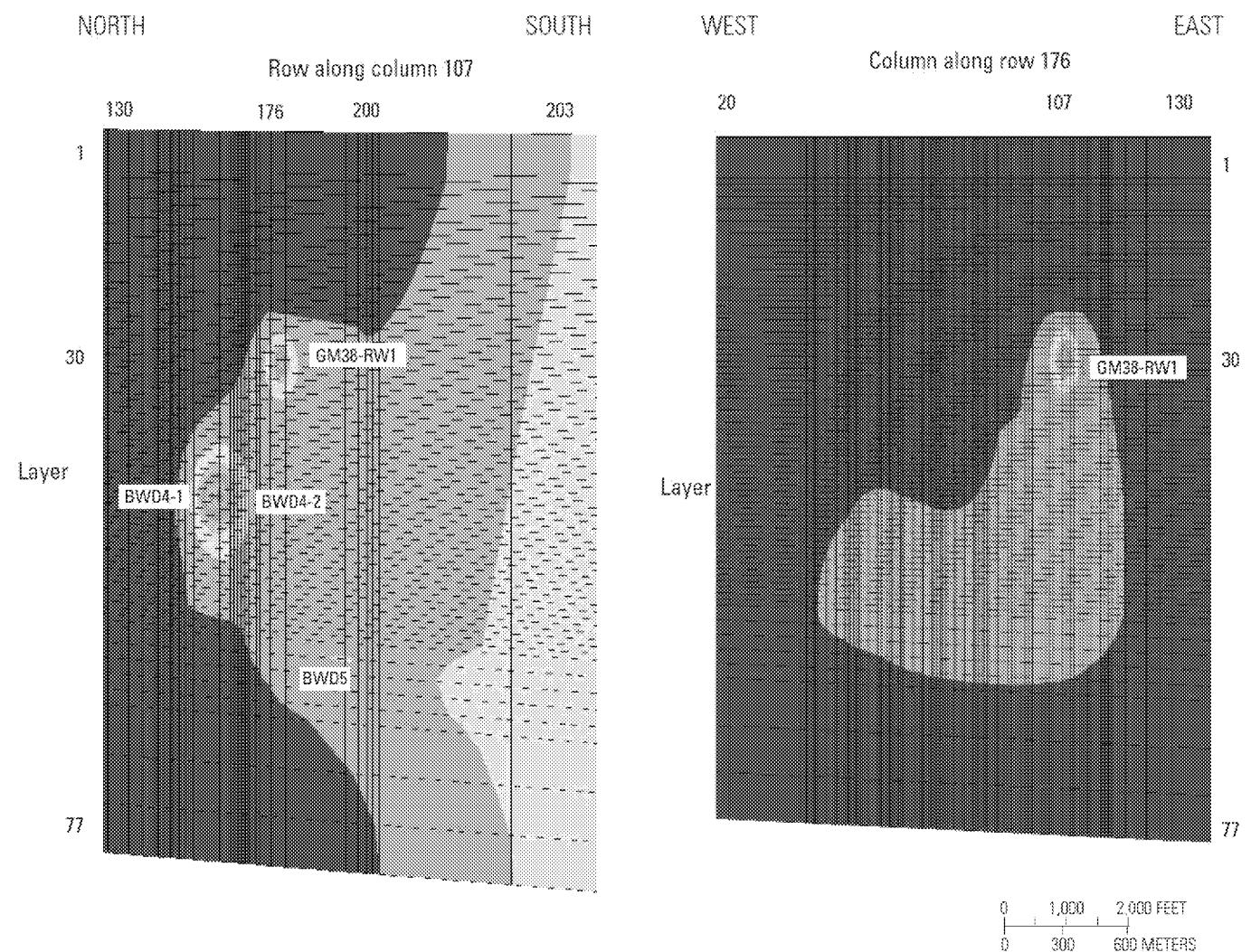
Realization: section



Alternate realizations: block series

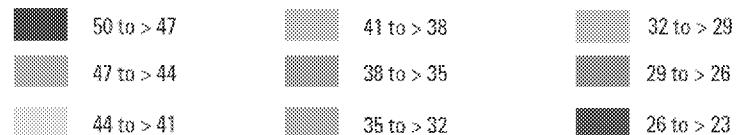


Simulation: sections



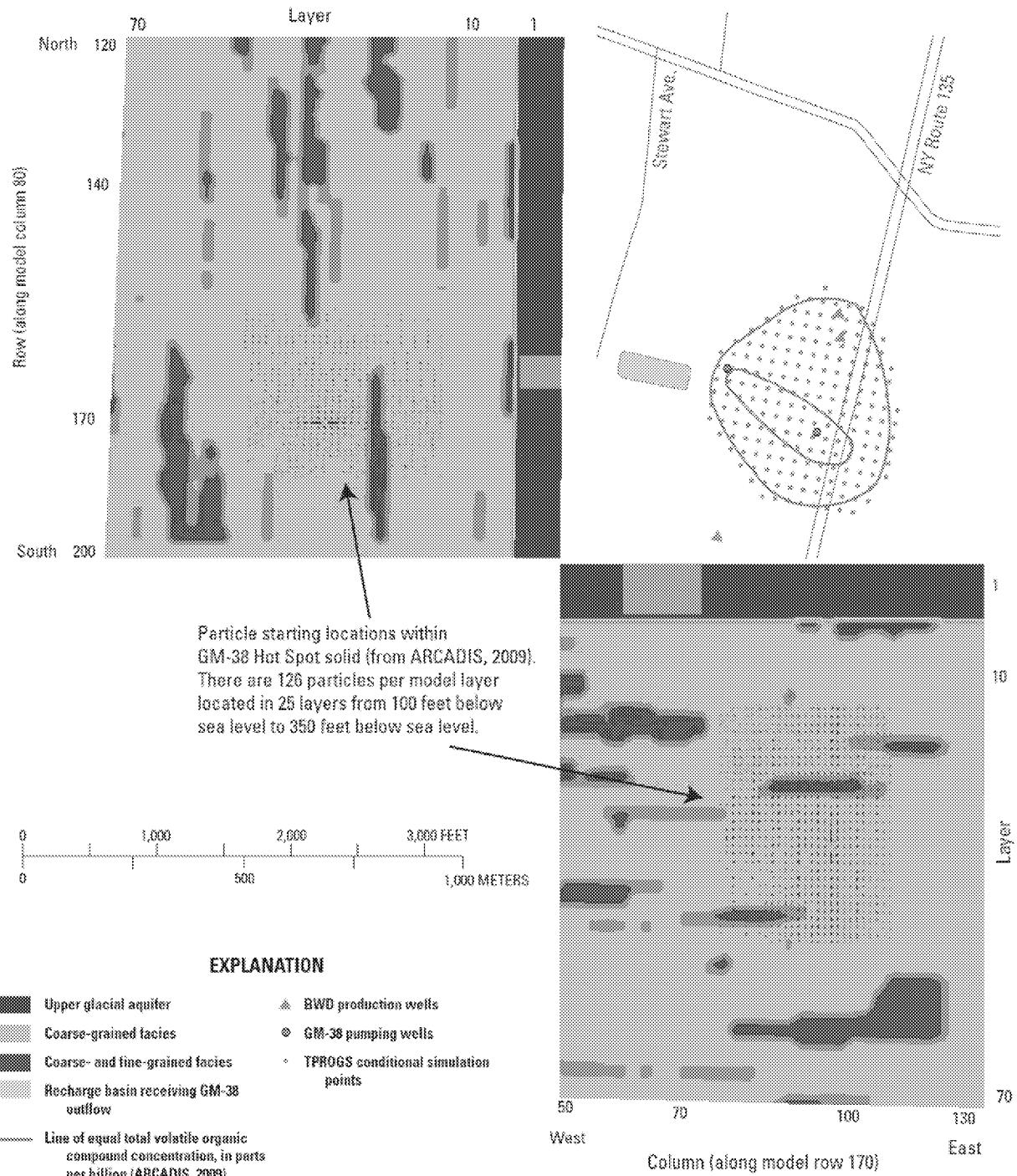
EXPLANATION

Simulated head, 3 foot color interval,
steady-state present conditions, NGVD 29

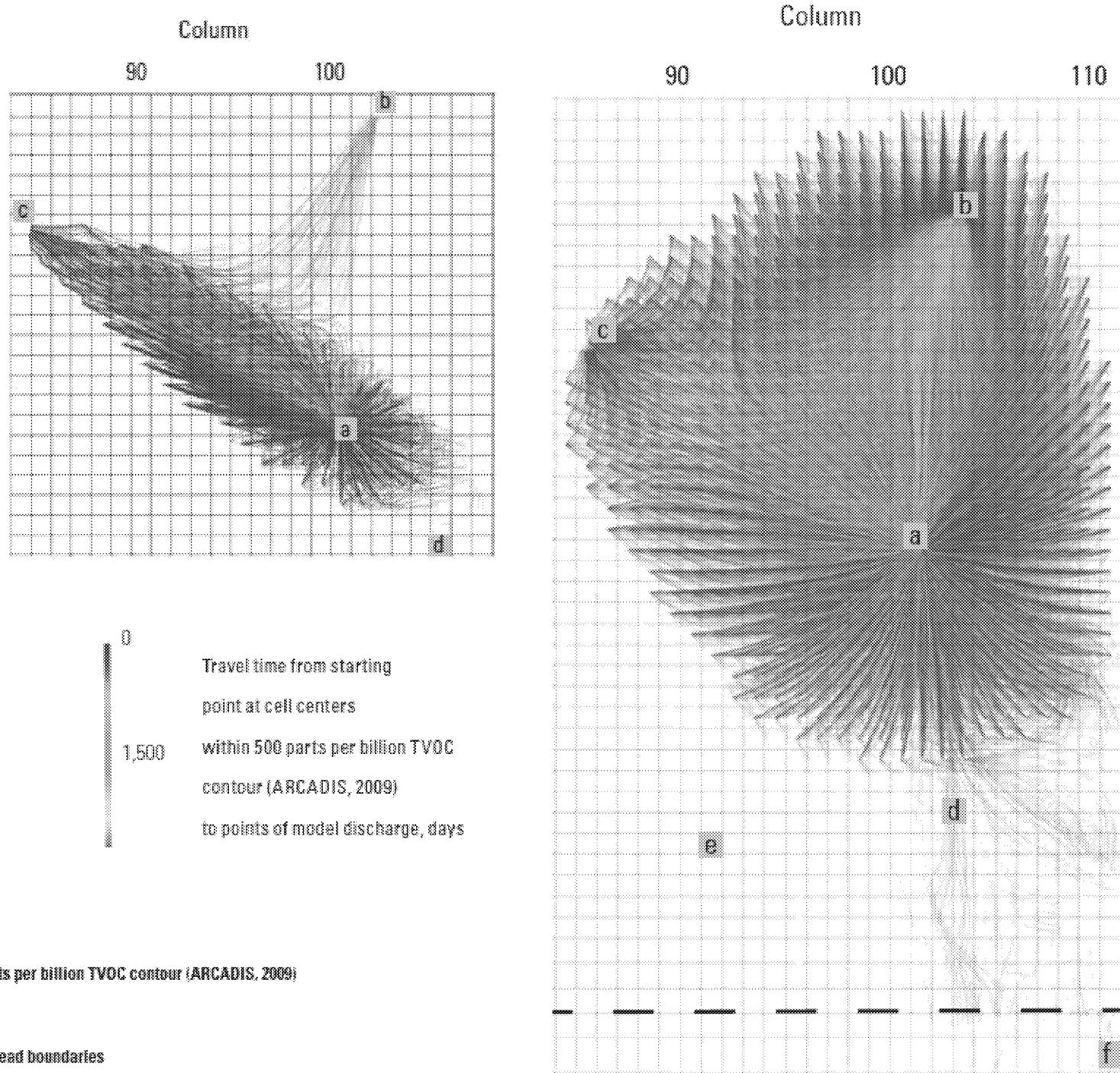


1. Heterogeneity
2. Forward tracking
3. Backward tracking
4. Conclusions

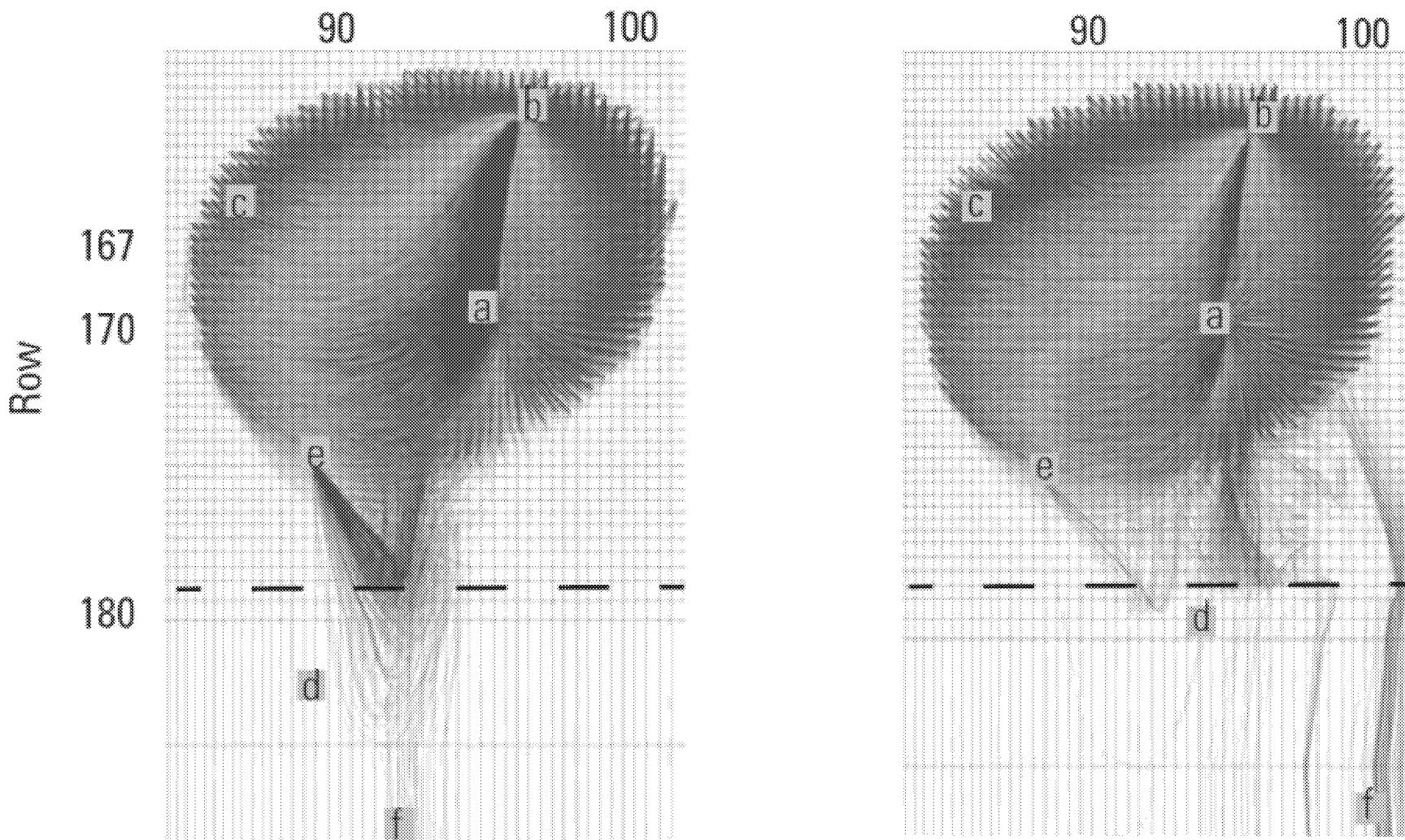
Plume cloud: foldout



Particle pathlines: map



Alternative realizations and plume clouds: maps

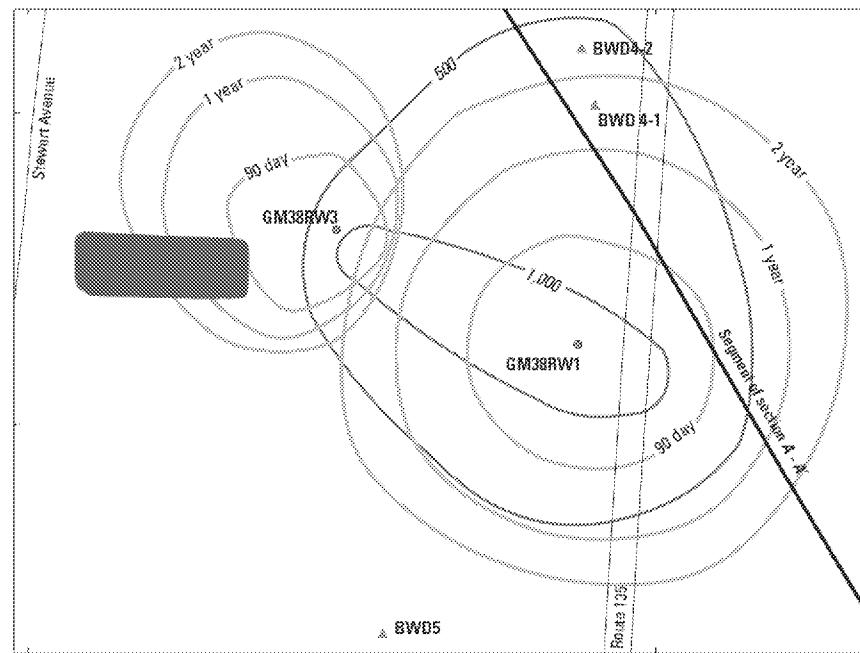


1. Heterogeneity
2. Forward tracking
3. Backward tracking
4. Conclusions

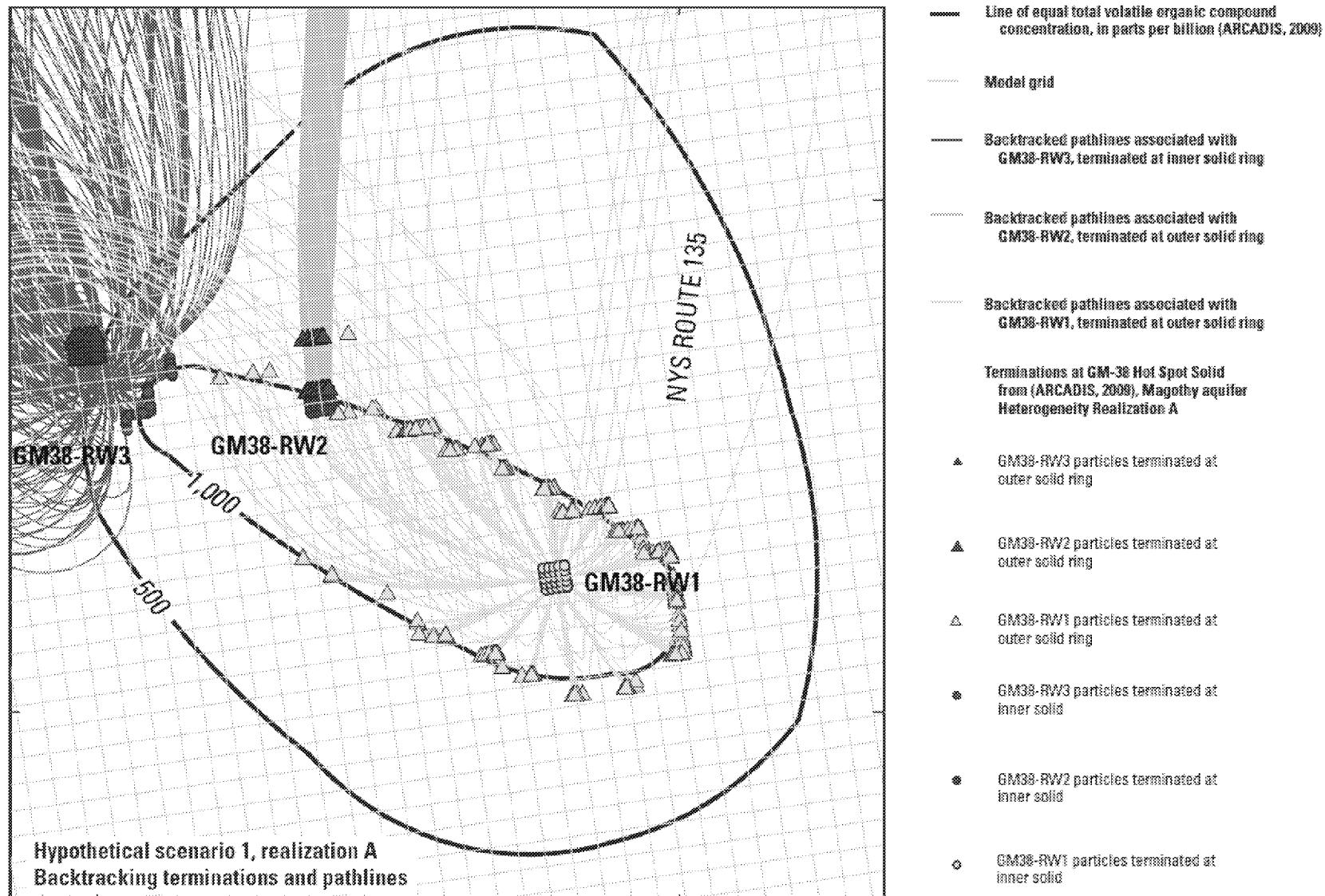
Capture zones:

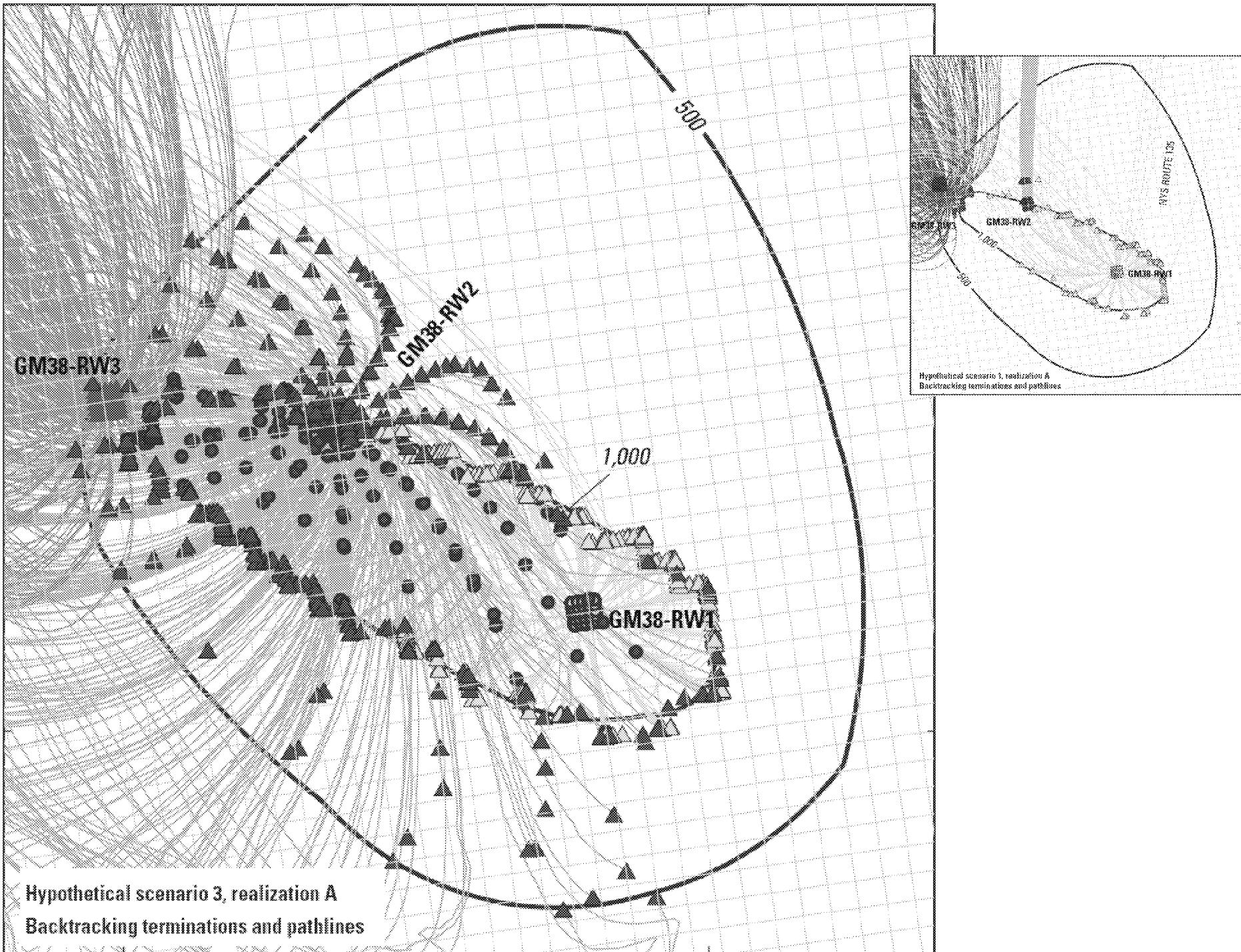
- Can show some information beyond the plume
- 2D drawing of maximum extent is simplification
- Technically no overlap
- Timing is arbitrary (*we also used approach of stopping particles at hot spot boundaries: MODPATH-OBS*)

- Recharge basin receiving GM-38 outflow
- Simulated zones of contribution, heterogeneity realization A—90 day, 1 year, and 2 year. Zones are delineated using backward particle tracking and represent projected maximum three-dimensional pathline extents.
- Line of equal total volatile organic compound concentration, in parts per billion (ARCADIS, 2009)
- ▲ BWD production wells
- GM-38 pumping wells



Pathline underflow and zone-intersection: map -percentages (capture efficiency measures) are analyzed in report





1. Heterogeneity
2. Forward tracking
3. Backward tracking
4. Conclusions

Study questions:

How does aquifer heterogeneity affect capture zone delineations?

- Probability model used to make alternative realizations of confining bed geometry from extensive VPB dataset
- structure reflected in simulated head distribution and MODFLOW parameter sensitivity analysis
- Structure makes a difference for plume tracking and well capture
- Only advection and head matching considered in study

Study questions:

How do forward tracking and backward tracking methods compare?

-forward represented fate of a plume cloud; did not show action upgradient

-backward represented hydraulics of capture throughout entire flow system

-MODPATHOBS software enhanced backtracking capability beyond typical capture zone approach

-both methods are affected by aquifer heterogeneity representation

Study questions:

How may the three GM38 pumping wells best be optimized and distributed?

- Scenarios of BWD4 shutdown and GM38-RW2 startup were considered
- Neither scenario improved capture efficiency
- In all scenarios, additional particles escape under the TCE hotspot
- Measures of underflow affected by heterogeneity realization